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ABSTRACT

This document contains a slightly-revised syllabus for a Virtual Reality course taught in spring 1994. The syllabus begins with an introduction which contains information on the software used in the course and examples of schools that have introduced virtual reality technology in the curriculum. The remainder of the document is composed of the syllabus, which begins by pointing out that the course features an emphasis on educational applications of virtual reality, including: (1) data gathering and visualization; (2) project planning and design; (3) the design of interactive training systems; (4) virtual field trips; and (5) the design of experiential learning environments. A definition of virtual reality follows, and the objectives of the course are listed. The schedule of class meetings, readings, and assignments is then given. Finally, four textbooks and eight articles designated as reading for the course are listed, and a bibliography of 20 additional resources on virtual reality and education concludes the syllabus. This document also includes copies of a set of overhead transparencies used with a paper on virtual reality that was presented at the Economics University in Prague, Czechoslovakia. (JLB)

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Virtual Reality: A Syllabus for a Course on Virtual Reality & Education

by Hilary McLellan, Ph.D.

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Virtual Reality: A Syllabus for a Course on Virtual Reality and Education

Hilary McLellan, Ph.D.

This past spring semester I taught a graduate seminar on virtual reality and education. A slightly spruced up version of the syllabus is presented here. Since this was one of the first educational technology courses to be taught concerning this emerging technology, the syllabus may be of interest to other educators. Based on my conversations with educators over the past few months, I am certain that there will be others designing and implementing courses about virtual reality and education. The software program Virtus Walkthrough that was used in the course I taught is a low-cost ($240) desktop program available for both the Macintosh and IBM platforms.

Newby (1993) points out that, "Education is perhaps the area of VR which has some of the greatest potential for improvement through the application of advanced technology. The lack of funding to place VR systems (or, in many cases, more modest educational technology) in public K-12 schools is the major impediment in this area. There are almost no articles in the literature describing research and potential applications in progress which fall clearly in the domain of education in K-12 or college. (p. 11)" Although most virtual reality technology is still quite expensive, a few secondary schools have started to use virtual reality technology. And there have been experimental programs where children are introduced to virtual reality technology, such as the programs by Bricken and Byrne (1993) and Merickle (1992) which are described later in this chapter. Furthermore, a number of museums have developed educational exhibits that feature virtual reality. This includes the Boston Computer Museum and the National Hockey League Museum.

One school that has introduced virtual reality technology is the Academy for the Advancement of Science and Technology in Hackensack, New Jersey. This Academy has installed immersive virtual reality technology that is used in the curriculum. The Bergan County Technical School District created the Academy in 1992 as a magnet school for delivering non-traditional education. According to District Superintendent John Grieco, visualization is the key to understanding and learning.

In England, the West Denton High School in Newcastle-on-Tyne is equipped with virtual reality technology (Connell, 1992). Under the direction of the school's ex-Headmaster, Michael Clark, sixth-formers helped to win a £100,000 contract from a consortium of local industries sponsored by the British Department of Labor to create three prototype virtual reality learning environments:

1. A dangerous workplace based around the hazards of an industrial workshop. Users will be able to explore the "workplace" as part of a health and safety training program. This application features a "virtual" factory where turbine engines are manufactured. The factory contains a bank of lathes, operated by push button control. The user can practice how this type of lathe would work in the real world, without the risk of real-life dangers.
2. An Intelligent City, based on part of a French city and containing support material introducing the user to the city. It will set tasks such as finding the way to a restaurant, buying a specific item or using the public transport system.
3. An Outdoor Gallery, designed to help architects and other interested parties select the best sites for public art. The Gallery will consist of photographs of Henry Moore sculptures in various simulated environments.

SEMINAR ON VIRTUAL REALITY
EDETC 886
Spring 1994
Monday, 7:00-9:30 PM
3 Credit Hours

Dr. Hilary McLellan

COURSE DESCRIPTION

This seminar will examine the emerging electronic technology known as virtual reality. There will be a lab component featuring the software program Virtus Walkthrough, an architectural walk-through program that is widely used in Hollywood for planning movie sets. (For example, Virtus Walkthrough had a role in the recent movies *The Firm, Adams Family Values, Jurassic Park, Fearless.*) This course will feature an emphasis on educational applications of virtual reality, including: (1) data gathering and visualization, (2) project planning and design, (3) the design of interactive training systems, (4) virtual field trips, and (5) the design of experiential learning environments.

Instructor: Dr. Hilary McLellan is a nationally recognized expert on virtual reality and education. She is a contributing editor of the monthly publication, Virtual Reality Report. She is on the editorial board of Virtual Reality World and served as an advisory editor of Virtual Reality: An International Directory of Research Projects (1993). Dr. McLellan has published many articles and has made presentations at national conferences on the subject of virtual reality.

What is virtual reality?

Virtual reality is a type of interactive computer-based application that provides a synthetic digital environment. Virtual reality evokes a feeling of immersion, a perceptual and psychological sense of being in the digital environment presented to the senses. Virtual reality represents the convergence of several disciplines, including human-computer interface design, simulation and data visualization, robotics, computer graphics, stereoscopy, and computer-aided design.

Virtual reality is a type of computer-based simulation. The simulation industry is virtual reality's primary precursor (in particular flight simulators). Virtual reality is a type of computer application for simulating environments, objects, actions, and processes. The technology of virtual reality lets you enter and interact with a world that is simulated more fully and convincingly than earlier simulations.

However, virtual reality is not just a simulation tool. It is a new type of human-computer interface that replaces traditional computer interface devices, such as keyboard and mouse, with devices that allow more intuitive interactions with data and involve our senses in new ways. Virtual reality is also a communication medium characterized by interaction and a sense of "presence." Virtual reality is a tool for problem solving and for visualizing and understanding data. Virtual reality provides a different way to see and experience information, one that is dynamic and immediate. Virtual reality is an artist's tool and a new artistic medium. It supports different modes of perception and perspective, emotion and thought. Virtual reality provides a medium for expressing concepts that cannot be said in words or in pictures alone. The purpose of virtual reality is to create an experience that occurs in physical reality or perhaps only in the imagination, representing ideas so we can move through them and manipulate them in ways we cannot in physical reality.

OBJECTIVES

Students will learn about virtual reality technologies, design issues, and applications, especially applications in education and training. Students will obtain hands-on experience designing non-immersive virtual reality walkthroughs.

1. Students will learn the basic categories of virtual reality technology.
2. Students will learn about the historical development of virtual reality.
3. Students will learn about different theoretical foundations of virtual reality.
4. Students will learn about existing and potential virtual reality applications in education & training.
5. Students will learn about the emerging virtual reality industry and technologies.
6. Students will develop virtual reality applications with the Virtus Walkthrough program.

SCHEDULE FOR EDETC 886: Seminar on VIRTUAL REALITY

Week 1 **1/17/94**	University holiday; no class.	
Week 2 **1/24/94**	Introduction to class; Introduction to virtual reality.	
Week 3 **1/31/94**	No class; work on readings.	Readings: Hamit, pp. 1-118.
Week 4 **2/7/94**	The virtual reality industry; Discussion of readings. Introduction to Virtus Walkthrough.	Readings: Hamit, pp. 119-204.
Week 5 **2/14/94**	Virtual reality: Introduction to theoretical aspects & design issues. Work in computer lab.	Readings: Laurel article.
Week 6 **2/21/94**	Introduction to virtual reality applications Discussion of readings; Work in computer lab.	Readings: Hamit, pp. 205-278.
Week 7 **2/28/94**	Virtual reality applications in education: Multiple intelligences, Constructivism, & Situated Learning. Discussion of readings.	Readings: McLellan articles; Bricken & Byrne.
Week 8 **3/7/94**	Introduction to Brenda Laurel's theoretical model. Discussion of readings.	Readings: Laurel, 1-124.

Week 9 3/14/94	Present first Virtus projects to the class. Discussion of readings.	Readings: Laurel, 125-198.
3/21/94	SPRING BREAK	
Week 10 3/28/94	Reports on chapters from Woolley book. Take-home midterm due.	Readings: Woolley.
Week 11 4/4/94	Reports on chapters from Woolley book.	Readings: Woolley.
Week 12 4/11/94	Reports on chapters from Woolley book.	Readings: Woolley.
Week 13 4/18/94	Work in computer lab.	Readings: Stephenson.
Week 14 4/25/94	Discussion of design themes in Snow Crash. Reports dues.	Readings: Stephenson.
Week 15 5/2/94	Present second Virtus projects to the class. Final projects due.	

EDETC 886 --- Virtual Reality: ASSIGNMENTS

Assignment	Due Date
1. Oral report on a chapter from the Woolley book or another reading assigned by the instructor.	See class schedule.
2. Report on virtual reality design themes featured in Snow Crash.	4/25/94
3. Virtus Design Project Number One.	3/14/94
4. Virtus Design Project Number Two.	5/2/94
5. Take-home midterm examination.	3/28/94
6. Participation in class discussions.	

EDETC 886 --- Virtual Reality: Detailed information about the assignments.

1. **Oral report on a chapter from the Woolley book or another reading assigned by the instructor.** Make a presentation to the class of the key ideas in one of the chapters in Benjamin Woolley's book. This book provides a broader context for understanding virtual reality by examining broader trends in a wide array of fields concerning how we are redefining our model of reality in many fields, including physics, mathematics, and finance. Chapter titles: Simulation,Virtuality, Computability, Artificial Intelligence, Cyberspace, Interface, Hypertext, Fiction, Hyperreality, Reality, Discovery.

2. **Report on virtual reality design themes featured in Snow Crash.** Science fiction often provides a window on the future (one analyst has suggested that there are two reasons why science fiction fails to capture the future: failure of imagination & failure of nerve). Stephenson's novel vividly portrays a virtual reality world called the Metaverse. His depiction of this fictional virtual reality world highlights some important design issues. Identify these design issues and discuss them in the context of Stephenson's examples and also in the context of the other readings for this class (you may even want to explore some additional references). What are the implications of the issues Stephenson raises for the design of virtual reality systems for education and training? In this paper, you should produce a comprehensive and convincingly argued evaluation; identify topics, describe them appropriately, and assert a judgment of them; give reasons and specific evidence to support the argument/opinion that you present; engage the reader immediately (make sure your account is interesting & well written), move along logically and coherently and provide closure (for each topic as well as the paper as a whole); reflect awareness of a reader's potential questions or alternative evaluations (and try to address them). Assessment of this report will include a consideration of the following criteria: grammar and punctuation, spelling errors that are clearly due to a lack of proof-reading, clarity and succinctness of writing, comprehensiveness, organization, inclusion of a personal response or assessment that is not limited to superficial considerations. Points will be taken off for all claims or assertions that are not supported by evidence and/or illustrating examples.

3. **Virtus Design Project Number One.** Using the Virtus Walkthrough program, develop a model of some type of small world: a neighborhood, a set design for a theatrical performance, an imaginary world, etc. Your Virtus model should include a guided tour feature or directed walkthrough. Prepare a brief report explaining the story or scenario behind your virtual world (i.e., What is it? Why did you choose this model to design).

4. **Virtus Design Project Number Two.** Using the Virtus Walkthrough program, develop a model of some type of small world: a neighborhood, a set design for a theatrical performance, an imaginary world, etc. Your Virtus model should include a guided tour feature or directed walkthrough. Prepare a brief report explaining the story or scenario behind your virtual world. This project should be completely different from the first Virtus project, but you can use the same theme.

5. **Take-home midterm examination.** This test will feature essay questions based on the readings and class lectures and presentations.

6. **Participation in class discussions.** Read the assigned readings carefully: Do you have questions? Opinions that you wish to share?

EDETC 886 Virtual Reality Seminar Readings

Texts:

Hamit, F. (1993). Virtual reality and the exploration of cyberspace. Carmel, IN: Sams.

Laurel, B. (1991). Computers as theatre. Reading, MA: Addison Wesley.

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Virtual Reality

By Hilary McLellan

Paper Presented at the Economics University in Prague,

Czech Republic, July 15, 1993.

Building upon the fields of computer graphics, human-computer interfaces and simulation, virtual reality was devised to enable people to deal with information more easily and to extend human perceptual capabilities.

Virtual reality is not limited to visual perception; virtual reality applications can include:

- vision
- hearing
- touch
- smell

Jaron Lanier, the brilliant young self-taught musician, computer wizard and visionary who coined the term 'virtual reality' and started the first VR company, suggests: "Virtual reality gives us another tool: we can directly create experiences for each other to share imagination, and this could be extraordinary."

DEFINITIONS

- Virtual reality can be defined as a class of computer-controlled, multisensory communication technologies.
- Virtual reality can also be defined as the environment created by a computer or other media, an environment in which the user feels present.

Different types of virtual reality:

- Immersive Virtual Reality
- Augmented Reality
- Mirror Worlds
- Through the looking glass or desktop VR
- First Person Cab Simulators
- Waldo Worlds (Virtual Actors)
- CAVE (3D Projection theater)
- Cyberspace
- Telepresence and Teleoperation

Immersive Virtual Reality

Immersive VR systems involve computer interface devices such as a Head-Mounted Display (HMD), fiber-optic wired gloves, fiber-optic wired bodysuits, and audio systems providing 3-D sound. The user is placed inside the image; the generated image is assigned properties which make it look and act real in terms of visual perception and in some cases aural and tactile perception. You can look at the things that surround you on all sides and you can walk around in the virtual space. The user enters the computational space rather than merely observing what's on a computer screen and interacting with it via keyboard or mouse.

Augmented Reality

Here a see-through layer of computer graphics is superimposed over the real world to highlight certain features and enhance understanding.

- For example, the landing controls of an airplane can be highlighted at the time of landing.
- Recently, for the first time, a surgeon conducted surgery to remove a brain tumor using an augmented reality system; a video image superimposed with 3-D graphics helped the doctor to see what he was doing.

Mirror Worlds

Mirror Worlds (Projected Reality) provide a second-person experience in which the viewer stands outside the imaginary world, but communicates with characters or objects inside it. These systems use a video camera as an input device. Users see their images superimposed on or merged with a virtual world presented on a large video monitor. Using a digitizer, the computer processes the users' images to extract features such as their positions or movements. For example, in the Mandala system, a video camera above the computer screen captures an image of the user and places this image within the scene portrayed on the screen using computer graphics. The user can interact with objects on the screen (play a drum or hit a ball).

Through the looking glass/Desktop VR

Desktop Virtual Reality provides VR on a Macintosh or IBM personal computer --- it's not full immersion, but it's a start. One desktop VR program, *Virtus Walkthrough* is now used as a set design and planning tool for most Hollywood movies. This started with the movie *The Abyss*, directed by James Cameron, who wanted a computer visualization tool to help plan complex high-tech filmmaking; *Virtus Walkthrough* was developed and has since been turned into a commercial product by the Virtus Corporation of Cary, North Carolina.

First Person Cab Simulators

Cab simulators are simulators for one or several persons to enter for a first-person experience in a virtual environment. This application is becoming increasingly important in location-based entertainment. It is also valuable for training. For example, a cab-simulator-based training program for training police officers is in use by several local police forces in California and Canada.

Waldo Worlds

This is a form of digital puppetry involving real-time computer animation. Virtual Actors are computer-generated characters or objects whose movements are controlled by human actors, in real-time. To perform the Virtual Actor, a human actor wear a "Waldo" -- a special facial input device -- which tracks the actor's eye brows, cheek, head, chin, and lip movements, allowing them to control the corresponding features of a computer generated Mario with their own movements.

Virtual Actors

A hidden video camera aimed at the audience is fed into a video monitor backstage so that the actor wearing the Waldo gear can see the audience and "speak" to individual members of the audience through the lip-synced computer animation image of the Mario character on the display screen. This digital puppetry application is like the Wizard of Oz interacting with Dorothy and her companions: "Pay no attention to that man behind the curtain!"

CAVE (3D Projection theater)

Created by the Electronic Visualization Laboratory at the University of Illinois, this 3D real-projection theater is made up of 3 walls & a floor, projected in stereo and viewed with "stereo glasses." As the viewer wearing a location sensor moves within the display boundaries, the correct perspective and stereo projections of the image are updated and the image moves with & surrounds the viewer. Operates with 5 computer workstations. Recently developed into a commercial product by a Chicago company.

Cyberspace

Cyberspace is a global artificial reality made up of databases that can be visited simultaneously by many people. The word "cyberspace" was coined by William Gibson, author of *Neuromancer* (1986) and several other science fiction books, about a future dominated by vast computer networks and databases.

John Perry Barlow: "Cyberspace is where you are when you're on the telephone." Cyberspace is also where you are when you're hooked up to a computer network or electronic database. We now have an electronically networked coffee house, Electronic Cafe International, headquartered in Santa Monica, California, which links people at about 60 sites around the globe (including the inhabitants of the Biosphere near Tuscon, Arizona) via video and computer for talk, music and performance art conducted jointly by people at the various sites. We also have electronically networked simulators, such as the Army's SIMNET system, where soldiers at different locations can can train for warfare in Cyberspace.

Telepresence and Teleoperation

Telepresence is the feeling of being in another location. Teleoperation means that you can control a robot or another device at a distance. The movie *Dave* has an example of teleoperation; the character played by actor Kevin Kline demonstrates teleoperation of two robot arms.

Telepresence Surgery

Surgeon Richard Satava is pioneering telepresence surgery; you can have your gall bladder removed without any direct contact from the surgeon after an initial small incision --- a robot does the rest, following the movements of the surgeon's hands at another location. What if an astronaut needed an emergency appendectomy while on a space shuttle mission? Telepresence surgery can someday be carried out in space, on the battlefield, or on the other side of the globe, without actually sending the doctor.

The Jason Project

In the Jason Project, children at different sites across the U.S. have the opportunity to teleoperate the unmanned submarine Jason, the namesake for this innovative science education project directed by Robert Ballard, a scientist at the Woods Hole Oceanographic Institute.

Educational applications for virtual reality:

(1) modeling complex phenomena
(2) project planning and design
(3) the design of interactive forms of entertainment and learning
(4) communication and control at a distance
(5) telepresence, including virtual field trips
(6) the design of experiential learning environments
(7) special education

VR at West Denton High School

In England, there's a high school equipped with virtual reality technology. The West Denton High School in Newcastle-on-Tyne is in an economically depressed area. But a visionary headmaster became interested in virtual reality early on and convinced British VR companies to donate equipment to the school. Now, a consortium of several companies sponsored by the British Department of Labor has provided the school with funding to create three prototype VR learning environments:

1. A dangerous workplace based around the hazards of an industrial workshop. Users will be able to explore the "workplace" as part of a health and safety training program. This application features a "virtual" factory where turbine engines are manufactured. The factory contains a bank of lathes, operated by push button control. The user can practice how this type of lathe would work in the real world, without the risk of real-life dangers.

2. An Intelligent City, based on part of a French city and containing support material introducing the user to the city. It will set tasks such as finding the way to a restaurant, buying a specific item or using the public transport system.

3. An Outdoor Gallery, designed to help architects and other interested parties select the best sites for public art. The Gallery will consist of photographs of Henry Moore sculptures in various simulated environments.

The project at West Denton will initially use a desktop-based virtual reality system. However later versions may use fully immersive virtual reality if the technology becomes more affordable. "A" level students at West Denton High School will be developing these applications.

Academy for the Advancement of Science and Technology

The Academy is a magnet high school in the Bergan County Technical School District in Hackensack, New Jersey. It has integrated virtual reality technologies into its curriculum. The first system installed consists of two IBM 486 PCs, the WorldToolKit software package by Sense8 Corporation and a CRT-based stereoscopic head-mounted display by Virtual Reality, Inc.

VR with kids

Several companies that produce virtual reality hardware and software (VPL Research, Inc., AutoDesk, and Sense8) have conducted projects where children in nearby schools have the opportunity to design and explore virtual worlds. Using VR equipment from AutoDesk, Merickel (1990) explored children's perception of 2-D and 3-D graphics as the basis for his doctoral research at Oregon State University. Over the past few years, researchers at the Human Interface Technology Lab at the University of Washington, a leading center of VR research and development, have carried out projects where children designed and explored virtual worlds.

Ken Pimentel (Sense8 Corporation) and Kevin Teixeira (Intel VR Project) (1992) speculate that "a new literacy" will be associated with virtual reality: "one that is behaviorally based as well as cognitively based. When a designer constructs a world, he'll be forced to consider the actions he's taking a user through." Pimentel and Teixeira speculate that virtual reality is "part of a paradigm shift as our civilization comes to terms with the powerful new information it has developed. As we learn to harness the power of virtual reality, we'll be moving from an information-based age to a knowledge age, in which information serves us."

Groupware

Groupware is a group of technologies, techniques, and services designed to help people collaborate more effectively, productively, and creatively. Groupware can consist of hardware, software, services, and support. Groupware is based upon the convergence of networking and multimedia technologies. This collaborative computing utilizes networking, communications, concurrent processing, and windowing environments. Hypermedia can also be integrated. Specific media such as voice and video can play major roles in collaborative computing, although their full integration is complicated.

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